Research Article
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The spatial and temporal emissions of carbon monoxide (CO) from municipal solid wastes dumpsites in Bayelsa state Nigeria

Abstract

The open burning of unsegregated waste has become a major global social, environmental, and public health problem due to toxic emissions released into the atmosphere. This study focused on assessing the spatial and temporal levels of Carbon Monoxide (CO) from the open burning of dumpsites in Yenagoa Metropolis, Nigeria. A portable AEROQUAL meter was used for the air sampling from 7 locations, including the control station. The result shows that the spatial and temporal levels of CO ranged from 0.11–0.89ppm and 0.19–0.83ppm respectively, and below the detection limit in the control station. The air quality health risk assessment model for CO emission shows that it was safe in some areas, moderate, unsafe for a sensitive group, very unhealthy, and even hazardous in some cases. This study strongly recommends that the level of CO emission associated with the open burning of waste monitored in order to avert adverse effects.

Keywords: carbon monoxide, air quality, municipal waste, Bayelsa State, Nigeria

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Abbreviations: CO, carbon monoxide; MSW, municipal solid waste; PM, particulate matter; PCDD/Fs, polychlorinated dibenzodioxin/dibenzofuran; AQI, air quality index

Introduction

In most developing nations, there is steady generation of Municipal solid waste (MSW) stream Society with challenges of segregation, reduction, reuse, and recycling due to inadequate administrative policies by Government, stakeholders, and policymakers. The rate of MSW generation tends to increase in developing countries with an increase in income level and population threshold.[1,2] The conservation of biodiversity through environmental sustainability is largely dependent on major resources like soil, water, and ambient air quality.[3]

Carbon monoxide (CO) is a toxic gas that is characterized by a colorless, odorless, and tasteless attribute having a water solubility level of 60% in oxygen. The degree of atmospheric exposure can rise to 0.8ppm, and even 50ppm in metropolitan traffic.[4] As established in literature the overall annual anthropogenic release of CO has been estimated to be around from the global and anthropogenic sources are estimated to be between 1000–3000Tg.[5] Unfortunately, the open burning of MSW have become a deliberate, neglected and underrated source of air pollution in most developing nations.[6–8]

In an attempt to reduce piles of waste that deface the environment, they tend to burn the waste in the open air releasing toxic airborne contaminants. The environmental and public health impacts of these pollutant emissions including CO, Sox, NOx, particulate matter (PM) and polychlorinated dibenzodioxin/dibenzofuran (PCDD/Fs, have become a major problem.[9] The practice of open burning of waste has caused global social, public health and environmental, and social issues including over 200,000 annual premature deaths.[7] There are limited information on the profiling of air quality around dumpsites in developing nations including Nigeria, this study, therefore, seeks to profile the spatial and temporal emissions of CO from Municipal Solid wastes dumpsites in Bayelsa State Nigeria.

Materials and methods

Study area

Bayelsa State is a wetland in the southernmost part of Nigeria located on latitude N04° 56' 57.8" and longitude E006° 20' 08.2". Bayelsa State has 8 Local Government areas and its capital city is Yenagoa, it has a population strength of over 1.7 million,[10] and a landmass of 10,773km^2 (4,159sq mi). It has one of the largest mangrove and crude oil deposits and an increasing level of urbanization due to employment opportunities in the industrial sector.

Sampling of air quality

The sampling of air quality for CO was investigated using a portable hand-held Aeroqual meter (AEROQUAL Series 300-New Zealand). The meter was powered and probed for possible emission at an average height of 2 meters in the prevailing wind direction and flow rate of 2.83L/min.[3] The sampling was carried out in triplicate to ensure accuracy of data during sampling.

Air quality modeling and risk assessment

The schemes of Jayaraman,[11] Ligan et al.,[12] and Wang et al.,[13] as shown in Table 1, were adopted for the health risk modelling of CO. Their median and geometric mean values were calculated using the formula for Air Quality Index (AQI); described below:

$$AQI = \frac{C_i}{S_i} \times 100$$

Where AQI = Air quality index

C_i = Individual concentration of the monitored pollutant

S_i = geometric or median mean

Table 1 Range of threshold values for health risk assessments of AQI Index

Safe [0-50]	Moderate [51 -100]	Unsafe for sensitive group [101 -150]	Unhealthy [151 – 200]	Very Unhealthy [201 – 300]	Hazardous [>300]

Statistical analysis

Version 23 of SPSS-23 was used for the statistical analysis. Analysis of Variance (ANOVA), was used for mean separation, while Duncan multiple range Post Hoc (p=0.05), was used to establish the degree of significance. Charts were plotted using the Microsoft excel package.

Results and discussion

Results on the mean spatial variation of CO are presented in Figure 1. Results showed that CO levels ranged from 0.11 – 0.89ppm, with the highest emission in Location L5, and the lowest emission in Location L4. apart from stations LA and LB. In addition, the control station (LX) indicated a significant difference ($p<0.05$) compared to values in other stations (Figure 1). In addition, average levels of CO emission in the control station were the lowest with a value of 0.02 ppm.

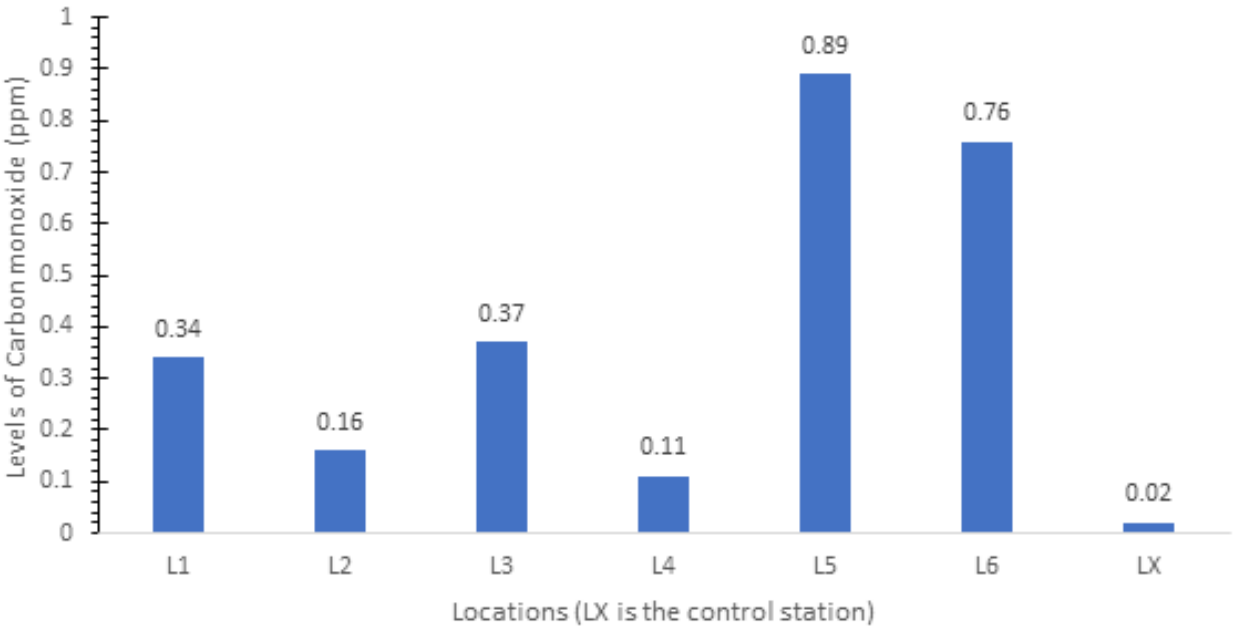

Figure 1 Spatial means emission of CO emission around the dumpsites.

Results on the mean temporal variation of CO are presented in Figure 2. Results showed that CO levels ranged from 0.19–0.83ppm, with the highest emission in the month of January during the dry season. On the other hand, the lowest emission in April and June is during the wet season (Figure 2).

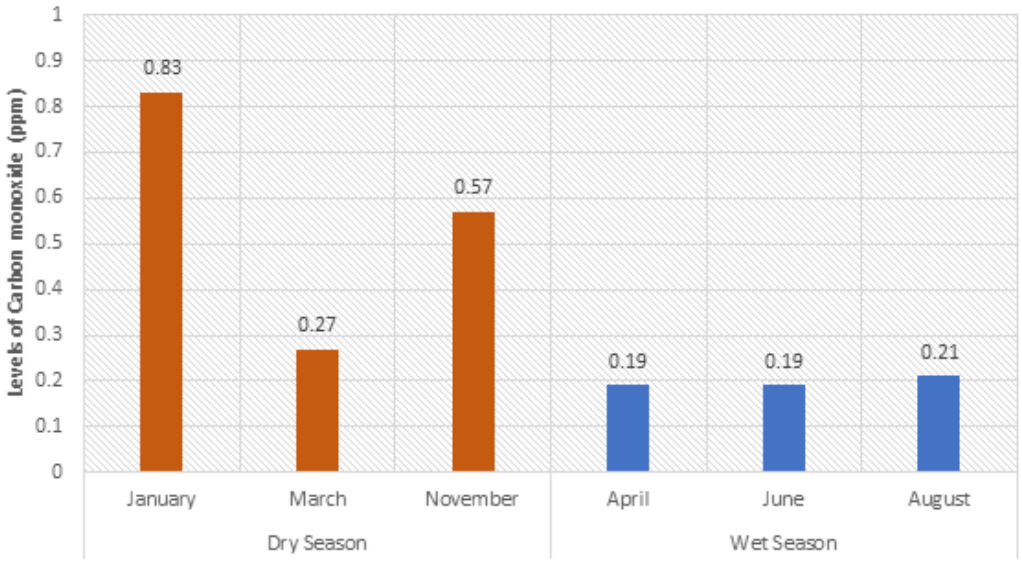

Figure 2 Temporal mean emission of CO around the dumpsites.

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The health risk assessment of the levels of CO associated with the dumpsite in all stations is presented in Table 2. The health risk profile at station LA showed that the levels of CO were safe except for the dry season when the Geometric mean scenario model was applied. In location LB, the health risk assessment model showed that levels of CO emission were safer in the wet season for both median mean and Geometric mean scenarios, but moderate in the dry season. The health risk of CO in LC was unsafe for a sensitive group of people with exception of the wet season using the geometric mean scenario. In Location LD, the CO emissions were safe in both seasons and scenarios. Meanwhile, in Location LE the CO was very unhealthy and even hazardous in the wet season for the geometric mean scenario. The CO emission in Location LF showed that it was unsafe for the sensitive group in the wet season for the median mean, very unhealthy in the dry season for both the median and geometric mean, and hazardous for the wet season using the geometric mean model (Table 2).

Table 2 Health risk assessment of volatile organic compounds associated with the dumpsites

Locations	Median mean scenario		Geometric mean scenario	
	Dry season	Wet season	Dry season	Wet season
LA				
LB				
LC				
LD				
LE				
LF				

Safe [0-50]	Moderate [51 -100]	Unsafe for sensitive group [101 -150]	Unhealthy [151 – 200]	Very Unhealthy [201 – 300]	Hazardous [>300]

The levels of CO in our study are comparable with the study of Ezekwe et al.,[13] where CO levels ranged from 0.00–4.00ppm; Imo State (0.02–0.30ppm) by Ubouh *et al*.,[14] and Ebonyi State (1.74–1.90ppm) by Njoku. Additionally, the study by Uba (2015) had higher CO of 1.50–10.50ppm and 1.50–11.40ppm in dry and wet seasons respectively. Higher CO level ranging from 133.7–141.6ppm was also reported by Rim-Rukeh.[15] Besides the greenhouse effects caused by CO gas, it had been reported to have health hazards like; bronchial constriction, pulmonary resistance, irritation of the mucous membrane, and vision impairment (ASTDR, 2001), and exposure at a higher level can cause fatalistic disruptions of hemoglobin level which often result to carboxylic-hemoglobin.[15]

Conclusion

The spatial and temporal levels of CO emissions associated with Municipal Solid Waste were assessed. Based on the Air Quality Index (AQI) MODEL assessment, CO emissions from most dumpsites were safe, except for the two stations of the central dumpsites (LD and LE) which recorded a very toxic emission. The levels of CO associated with the open burning of MSW should be monitored in order the mitigate the adverse effects. In addition, policies to minimize the reckless dumping of waste streams and deter anthropogenic activities should be adopted.[16,17]

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None.

Conflicts of interest

The authors declared that there are no conflicts of interest.

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